science

chemistry

GCSE C8 – Analytical Chemistry

1) What is a pure substance?

- A **pure substance is a single element or compound**, not mixed with any other substance.
- Pure elements and compounds melt and boil at specific temperatures.
- Melting point and boiling point data can be used to distinguish pure substances from mixtures.

2) Impure substances (mixtures)

- **Impurities lower the melting point** and change the boiling point.
- Impure substances melt over a larger range of temperatures.
- The greater the amount of an impurity, the bigger the differences from the true melting point and boiling point.

3) Formulations

- A **formulation is a mixture** that has been designed as a **useful product**.

- Formulations are made by mixing the components in carefully measured quantities to ensure that the product has the required properties.
- e.g. fuels, cleaning agents, paints, medicines, alloys, fertilisers and foods.

4) Gas tests

Hydrogen – Use a burning splint held at the open end of a test tube of gas and you will hear a squeaky pop.

Oxygen – Use a glowing splint inserted into a test tube of the gas. The splint relights in oxygen.

Carbon dioxide – Bubble gas through limewater (aqueous calcium hydroxide solution) and the limewater turns milky (cloudy).

Chlorine – Damp litmus paper is put into chlorine gas the litmus paper turns pink and then is bleached and turns white.

5) Chromatography & analysis

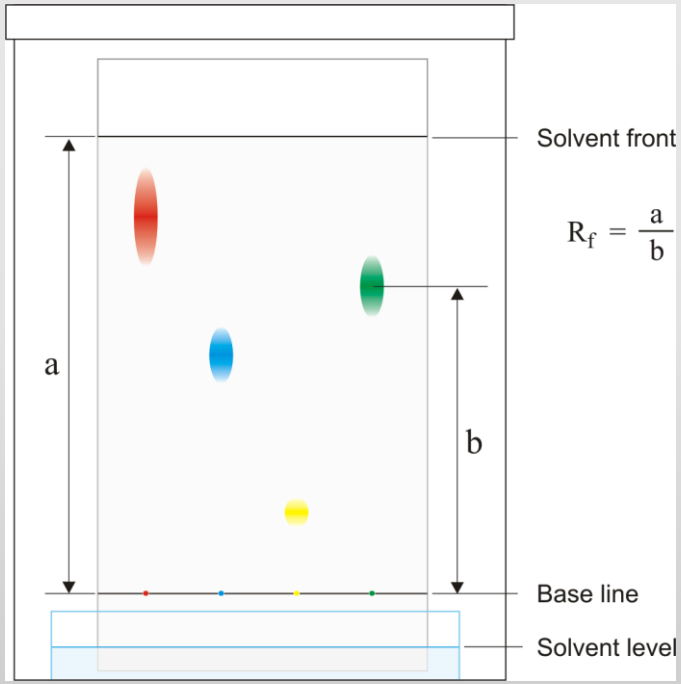
- Instrumental methods provide fast, sensitive and accurate means of analysing chemicals, and are particularly useful when the amount of chemical being analysed is small.

- Elements can be identified using chromatography.
- Involves a stationary phase and a mobile phase. Separation depends on the distribution of substances between the phases.

- Paper chromatography can be used to separate mixtures, such as food colourings.
- The solvent (usually water) moves up the paper and the more soluble the dye the further it travels up the paper.
- If there are three dots on the paper in the same vertical column, it tells you that there are at least three dyes in that mixture.

6) Required Practical – Chromatography

- Using a ruler, mark a line in pencil 2cm from bottom of paper.
- Put a drop of your sample evenly spaced on the pencil line.
- Place the paper in a small amount of solvent, keeping the pencil line above the solvent.
- Allow the solvent to travel to about 2/3 the way up.
- Mark off with a pencil line the solvent front
- Compare your unknown sample with known samples.



$$R_f = \frac{distance\ moved\ by\ substance}{distance\ moved\ by\ solvent}$$

Rf (retention factor) values can be used to compare your data from the chromatogram to a database (as long as the same temperature and solvent is used for the experiment).

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GCSE C8 – Analytical Chemistry (single chemistry only)

7) Flame tests

- To identify an unknown cation, dip a nichrome wire loop in to some of the unknown sample and pass it through a blue Bunsen flame
- Observe the colour of the flame.
- Clean the wire loop by dipping in HCl before repeating

Lithium ions (Li^+) – crimson
Sodium ions (Na^+) – yellow
Potassium ions (K^+) – lilac
Calcium ions (Ca^{2+}) – orange-red
Copper ions (Cu^{2+}) – green

If a sample containing a mixture of ions is used some flame colours may be masked. Some elements also have very similar colours.

8) Using sodium hydroxide

- Add sodium hydroxide solution to your sample.
- Observe the colour of the precipitate (solid) formed.

- **Aluminium, calcium and magnesium ions** all produce a white precipitate but only the aluminium precipitate dissolves in excess NaOH.

- **Copper II ions (Cu^{2+})** – blue precipitate of $Cu(OH)_2$

- **Iron II ions (Fe^{2+})** – green precipitate of $Fe(OH)_2$

- **Iron III ions (Fe^{3+})** – brown precipitate of $Fe(OH)_3$

e.g. $FeCl_{3\,(aq)} + 3NaOH_{(aq)} \rightarrow Fe(OH)_{3\,(s)} + 3NaCl_{(aq)}$

9) Halides (Cl^-, Br^-, I^-)

- Add nitric acid followed by silver nitrate solution
- Observe the colour of the silver halide formed.

- Silver chloride forms a white precipitate
- Silver bromide forms a cream precipitate
- Silver iodide forms a yellow precipitate

e.g. $NaCl_{(aq)} + AgNO_{3\,(aq)} \rightarrow AgCl_{(s)} + NaNO_{3\,(aq)}$

10) Sulfates (SO_4^{2-})

- Add hydrochloric acid followed by barium chloride solution.
- If sulfate ions are present a white precipitate of barium sulfate forms.

$Na_2SO_{4\,(aq)} + BaCl_{2\,(aq)} \rightarrow BaSO_{4\,(s)} + 2NaCl_{(aq)}$

11) Carbonates (CO_3^{2-})

- Add any dilute acid (e.g. hydrochloric)
- If carbonate ions are present the acid will fizz (effervesce) as carbon dioxide is produced.
- Bubble the gas through limewater which will go cloudy.

$CaCO_{3\,(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2\,(aq)} + H_2O_{(l)} + CO_{2\,(g)}$

12) Required Practical – Identifying ions

You should be able to describe all of these tests to identify unknown samples containing any of the ions mentioned on this page.

e.g.
To identify an unknown cation, you could either use a flame test (box 7) or sodium hydroxide (box 8).

To identify an unknown anion, perform the tests in boxes 9, 10 & 11.

13) Instrumental methods

Using machines and computers to analyse unknown elements and compounds is better because they are:

- Accurate
- Sensitive (tiny mounts can be detected)
- Rapid

- However they are more expensive.

14) Flame emission spectroscopy

This is an example of an instrumental method of analysis.

The sample is put into a flame and the light given out is passed through a spectroscope. The line spectrum produced can be used to identify the metal ions present and their concentration.